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Decision making processes and factors driving apple protection strategies at farm level

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1 Introduction

Apple growers apply numerous chemical treatments to protect fruits from both pests and diseases. Alternative methods exist but their efficiency on pest control can be limited, while public regulations, retailers, supermarkets and consumers are increasingly demanding regarding fruit sanitary quality, both on national and export markets (Simon et al., 2011; Drogué and DeMaria, 2012). Few pesticide residues, no symptom of diseases, standardized visual aspect and high nutrient quality are then included in contract specifications putting pressure on apple growers and their first buyers to fulfill all these requirements (Simon et al., 2010). In that context encouraging transitions towards sustainable practices requires understanding decision making processes and factors that drive growers' design and implementation of crop protection strategies at farm level, where trade-offs have to be made regarding allocation of resources between farm activities. This ongoing study is based on semi-qualitative surveys of 35 apple farms. It characterizes the diversity of their protection strategies, according to their natural environment, their own resources and their marketing strategy, and identifies the decision-making processes and factors that drive this diversity.

2 Materials and Methods

The study has been carried out in South-East and Center-West of France. Orchards of the South-East region are more susceptible to insects due to a hot and dry climate, while the wetter climate of the Center West region makes them more susceptible to fungal diseases. Interviewed growers were selected in order to have a diversified sample regarding their main market channel, i.e. Apple Grower Cooperatives (AGC) and self-sellers, their farm circumstances and their protection practices. One AGC per region was studied and 10 to 13 members were interviewed per AGC. Twelve self-seller growers were also met per area. AGC growers were selected based on the diversity of protection practices observed in the AGC database storing the crop protection treatments applied by all their members every year. Self-sellers were contacted based on local networks and selected for their diversity of both context and assumed practices. Individual semi-structured interviews were conducted to better understand growers' protection strategies and practices. Technicians supporting growers in their protection management were also interviewed in order to understand the way they provide advices and their relationship with growers. Protection practices were analyzed based on the whole annual set of treatment records per grower. Practices were differentiated according to the type of products used rather than the number of sprays, which is linked to the annual weather context. Six protection strategies were identified based on the following orchard management variables: selection of market segment, selection of planted varieties, selection of restricted pesticides, choice of alternative methods to pesticides, objectives of fruit quality.

3 Results

A set of common factors driving decision making processes: All the growers take their protection decisions according to a common framework including public regulations, private requirements, and climate. Public regulations define the authorized products, doses, mixes, pre-harvest intervals, maximum number of applications of a given product, and width of untreated areas. Every grower has to adapt his strategy to the public regulation rules and may be controlled in that respect by public officers. Private requirements imposed by buyers, especially supermarket chains and exporters, add specifications possibly stricter than public regulations, for instance regarding accepted number and quantities of pesticide residues. Requirements depend on the marketing channel or firm, but all the growers interviewed had contracted specific requirements with a given body such as AGC, organic certification agency or regional council (e.g. Sud Nature in Languedoc-Roussillon region). Daily climatic conditions also determine a set of decision rules such as disease control in relation with rainfall or treatment triggering in relation with wind speed.

But yet a diversity of protection practices in the same framework: Both AGC treatment databases and growers' interviews highlight the large diversity of practices encountered in a shared decision-making framework. A gradient arises from growers trying to avoid toxic pesticides and managing their orchard only with natural products to growers using only and frequently synthetic products. As a result application of pesticides varies largely in each treatment group (Table 1). This diversity within a same set of private specifications and climatic context is linked to each grower's own choices regarding the design and implementation of his protection strategy.

Table 1. Range of pesticide use according to the type of treatment in a given GO (# of copper/mancozeb-captan/sulphur based treatments over total # of fungicides, and # of bio-insecticides over total # of insecticides)

Treatment group	Treatment product	Range of treatment per farm (%)
Fungicide	Copper-based	0-44
	Sulphur-based	0-56
	Mancozeb/Captan-based	0-62
Insecticide	Bio-product	0-72

… Leading to six protection strategies: Six protection strategies were identified corresponding to specific combinations of five variables (Table 2). The growers adopting bio-ecologic (S1) and ecologic (S2) strategies aim to reduce chemicals use as much as possible in order to protect consumers and workers' health and the environment. In that respect they try to reach a balance between pests and natural enemies and to only use organic products and pesticide alternative methods such as releases of natural enemies and implementing bird nest boxes. Most of these practices are based on orchard observations. Since their apple yields are usually low (around 20t/ha), these growers target niche markets where apple is sold at higher prices than usual (1 to 2€/kg), such as short chain. They also valorize damaged apple as juice and they diversify their production with other crops to satisfy their customers. But since their incomes are not high enough to hire workers, they show a high workload seen as a major constraint for extending their activities. Compared to S2, S1 growers have self-imposed bans of authorized organic products that they think environmentally unsuitable because their formulation is based on toxic molecules for other insects. They experiment new protection practices such as biodynamic ones ahead of research institutes and are considered as information source.

The growers adopting the combined strategy (S3) aim to reach a trade-off between their income objective and their will to evolve towards sustainable practices. As such they try to achieve a high yield and commercial quality (premium fruits) to secure their income, by using both conventional and organic methods. They generalize alternative methods on their whole orchard, to jointly protect consumers, workers' health and environment. Most of these practices are based on orchard observations. All of them except one belong to AGC and their selling price is low, around 0.5€/kg with an average yield of 44t/ha. They work with several information sources and with AGC technicians.

The financial strategy (S4) is adopted by young producers or growers who have faced financial difficulties in the past few years. As AGC members they get low selling prices, 0.3€/kg. Thus they try to improve their financial situation by minimizing technical and economic risks, i.e. reaching high yields (e.g. 60-80t/ha for Golden) and high commercial fruit quality (premium category) while reducing production costs. As such they avoid using natural treatments like copper or bio-insecticides since they do not trust their pest control efficiency which could negatively impact their economic results. They are also careful with the number of sprays they apply in order to reduce costs. They are supported by AGC technicians to find trade-offs between their objectives of respectively high production and low protection costs.

The growers adopting the risk-limited strategy (S5) aim to maintain their good economic situation by reaching high yield and maximizing premium quality every year. They grow high valued cultivars like Pink Lady® and they combine apple production with other activities on the farm or outside the farm. The apple orchard is seen as a way to increase the farm profits independently of environmental impacts. They follow technician advice only (from AGC or agricultural chambers) in order to be sure to respect public regulation. As a consequence, their practices are influenced by technicians' advice. Their treatments are based on synthetic pesticides.

Compared to S5, the no-risk strategy (S6) regroups growers who aim not only to maintain but to maximize their profits by achieving the highest yields and quality. They are AGC growers with a strong link with their cooperative. Their focus is more on how to reduce production costs at a farm scale and maximize labor force and equipment efficiency, than changing their protection strategy.

Table 2. Characterization of the six protection strategies

	Growers (n)	% of surface with resistant cultivar	specific requirements contracted	Product self-restrictions	Alternative methods to pesticides	ectives of fruit quality*
S1: bio-ecologic	4	>50%	100% Organic or Biodynamic	Yes	4	A+G+S
S2: biologic	2	>50%	100% Organic	No	4	A+G+S
S3: combined	10	5-50%	5-50% organic/BabyFood	Yes	At least 2	A+C+G+S
S4: financial	6	<25%	No	No	0-1	C
S5: risk-limited	10	0%	No	No	0-1	C
S6: no risk	3	0%	No	No	1-2	C

*A: Agronomic; C: Commercial; G: Gustative; S: Sanitary

4 Discussion and conclusion

Although growers located in a similar area and AGC face common buyer specifications and weather conditions they show a diversity of protection strategies depending on a range of management components: the farm financial situation, selling prices according to their marketing strategy, their technical environment and information sources, their specialization in apple production. Formalizing the farm set of structural and management characteristics that drive growers' decision making processes is still in progress. Growers' own knowledge and values may also play a part in the strategy implemented. For instance, agroecological methods require new technical skills and some ecological consciousness. This complex combination of factors finally makes each farm a specific case that should require targeted support in order to evolve towards more agroecological protection strategies and practices.

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